IceCube: Neutrino Physics from GeV-PeV

IceCube collects of order 100,000 atmospheric neutrinos per year in the 0.1~100 TeV energy range. Both the high statistics and the higher energy range represent opportunities for discovery. Measurements of the atmospheric muon and electron neutrino spectrum[1] have been extended to 100 TeV; atmospheric events above this energy are extremely rare. Nevertheless 2 events with energy exceeding 1 PeV were discovered serendipitously in a search for cosmogenic neutrinos[2]; a dedicated search should reveal more such events in the same data set. This analysis is underway and may indicate whether we are observing a new source of neutrino fluxes, or neutrino interactions not described by the Standard Model.

With the low energy extension DeepCore, IceCube's threshold has been lowered to ~10 GeV over a significant effective volume. Using conventional IceCube analysis tools neutrino oscillations have been observed above the 5 sigma level[3], the development of methods specialized to low energy should result into a competitive precision measurement of the oscillation parameters. More importantly, IceCube studies oscillations at energies that exceed those of present experiments by one order of magnitude. This represents an opportunity for a highly sensitive search for any new physics that interferes with the standard oscillation pattern[4].

At TeV energy, the sensitivity of IceCube data to sterile neutrinos in the eV mass range potentially exceeds that of any other experiment[5] and is only limited by systematic errors[6]. A dedicated analysis is underway.

IceCube will observe the next Galactic supernova collecting over one million neutrinos in millisecond time bins from an explosion at the center of the Galaxy. The data has the potential to reveal a wealth of neutrino physics, including the hierarchy[7].

References:

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